



rec'd 12 dec. *12/13/94*  
*Patrick Wright*

**UNITED STATES DEPARTMENT OF COMMERCE**  
**National Oceanic and Atmospheric Administration**  
NATIONAL MARINE FISHERIES SERVICE

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DEC 8 1994

F/SW022:CTM

Mr. Harry Seraydarian  
Director  
Water Management Division  
U.S. Environmental Protection Agency  
Region 9  
75 Hawthorne Street  
San Francisco, California 94105-3901

Dear Mr. Seraydarian:

I apologize for the delay in responding to your September 28, 1994, letter concerning spring-run chinook salmon in the Sacramento River. Your letter specifically requested the National Marine Fisheries Service (NMFS) to provide the Environmental Protection Agency (EPA) with its views on measures necessary to protect spring-run chinook salmon in the Sacramento-San Joaquin Delta. In addition, you asked for NMFS views on the recommendations for protecting spring-run chinook salmon that were submitted by the Natural Heritage Institute (NHI) and others to the State Water Resources Control Board.

The NHI's key concern is that Sacramento River spring-run chinook salmon migrate through the Delta as yearlings during the period of November through January when very limited salmon smolt protection measures are currently in place. In order to reduce diversion of juvenile spring-run chinook salmon into the Central Delta and minimize adverse impacts associated with operation of the Central Valley Project (CVP) and State Water Project (SWP) pumping plants, NHI recommends the following measures:

- 1) Closure of the Delta Cross Channel from November 1 to January 31,
- 2) Export caps from November 1 through January 31 based on water-year type (as in Fish and Wildlife Service's Alternative D for fall-run chinook protections),
- 3) QWEST flows of positive 1,000 cfs from November 1 through January 31.

Timing of Spring-Run Outmigration

The results of a California Department of Fish and Game (DFG) fish monitoring program indicate that juvenile spring-run chinook



salmon leave Deer and Mill Creeks between November and March. However, it is unclear if these fish are actively undergoing smoltification and traveling through the Delta towards the sea during this period. Juvenile chinook salmon are known to move out of tributaries and into a river mainstem, or simply relocate downstream with the approach of winter<sup>1</sup>. Thus, it is possible that a significant portion of the total juvenile spring-run chinook salmon population spends some time during the winter months rearing in the mainstem before moving into the lower Sacramento River and Delta.

Healey (1993)<sup>2</sup> reports that yearling chinook salmon smolts normally migrate seaward in the early spring. Based on the results of a Sacramento River midwater trawl survey conducted between February 1973 and September 1974, Schaffter (1980)<sup>3</sup> concluded that yearling salmon from the upper Sacramento River outmigrate as smolts during February, March and April. If the spring-run chinook salmon from Deer and Mill Creeks more closely resemble the wild spring-run chinook populations that still exist in the Northwest, juvenile fish may leave their over-summering habitat in tributary streams during the fall and early winter to reside in the mainstem Sacramento River where they occupy deep pools and crevices through the winter. This information suggests that the outmigration of yearling spring-run chinook salmon smolts through the Delta may occur as early as November, but could also occur during the early spring. Unfortunately, data are not available from the Sacramento River to make any accurate estimate of the proportion of spring-run chinook salmon outmigrants which are moving through the Delta at any particular time of year.

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<sup>1</sup> Chapman, D.W., and T.C. Bjornn. 1969. Distribution of salmonids in streams, with special reference to food and feeding, p. 153-176. In: T.G. Northcote (ed.). Symposium of Salmon and Trout in Streams. H.R. MacMillan Lectures in Fisheries, Institute of Fisheries, University of British Columbia, Vancouver. B.C., 388 pp.

<sup>2</sup> - Healey, M.C. 1993. Life history of chinook salmon. In: Groot, C. and L. Margolis (eds.). Pacific Salmon Life Histories, University of British Columbia Press, Vancouver, B.C.

<sup>3</sup> - Schaffter, R.G. 1980. Fish occurrence, size, and distribution in the Sacramento River near Hood, California, during 1973 and 1974. CDFG Anad. fish. Admin. Rept. No. 80-3. 76 pp.

### Delta Cross Channel Closures

Juvenile chinook salmon emigrating from upstream spawning and rearing areas in the Sacramento River are susceptible to being diverted into the central Delta through the Delta Cross Channel. Fisheries investigations since the 1980's have shown that salmon smolts which pass into the interior Delta have substantially lower survival rates than those fish which remain in the mainstem Sacramento River. Closure of the Delta Cross Channel gates can reduce the diversion of chinook salmon smolts from the Sacramento River and their subsequent exposure to entrainment at the CVP and SWP pumping plants. Rearing juvenile chinook salmon will also benefit by remaining within the mainstem river and northern Delta until their smolt outmigration. For these reasons, I agree with NHI that closure of the Delta Cross Channel gates is an effective measure for protecting spring-run chinook salmon smolts. However, the uncertainty associated with the actual outmigration timing of juvenile spring-run chinook salmon needs to be resolved to maximize the protective value of this action.

Research on many river systems, including the Sacramento River, has shown that downstream movements of juvenile salmon tend to peak during storm and turbidity events. Therefore, the periodic closure of the Delta Cross Channel gates during the November through January period, which is a protective measure for winter-run chinook salmon in the NMFS's 1993 CVP-OCAP biological opinion, should also provide some protection for spring-run chinook outmigrants. NMFS is developing criteria for Delta Cross Channel gate operations based on real-time monitoring of Sacramento River storm and turbidity events and juvenile salmon outmigration pulses. I believe that a large portion of the juvenile spring-run chinook population will also be protected by these periodic gate closures since these fish are also likely to move downstream in response to storm and turbidity events. If periodic gate closures are well coordinated with juvenile migration pulses, this approach could provide protection for spring-run, winter-run, and late-fall run chinook salmon outmigrants with minimal impacts to hydrology, water quality, and navigation.

### Export Caps

The recommendation by NHI to cap exports based on water year-type will be difficult to apply from November through January because there is no way to make a reliable prediction of water-year type that early in the water-year. Although I agree that water export reductions may assist juvenile chinook salmon in safely passing through the Delta, virtually no information is available to identify the export levels which would be protective of spring-run chinook salmon during the months of November through January. Spring-run chinook outmigrants do have the advantage of a larger

size and better swimming ability during their outmigration period in comparison to the other Central Valley chinook races. Again, information regarding their Delta residence time and smoltification period is critical to the protection plan.

#### QWEST Restrictions

NHI points out that some salmon smolts will still get into the central Delta even with the Delta Cross Channel gate closures. Therefore, conditions must be maintained in the Central Delta which allow for safe rearing and reduce exposure to entrainment at the CVP and SWP pumping plants. NMFS's 1993 CVP-OCAP biological opinion requires the Federal and State water projects to maintain QWEST at levels greater than -2,000 cfs from November 1 to January 31, which is less protective than the 1,000 cfs recommended by NHI. However, uncertainty remains concerning the optimal period for implementing these actions. There is also a benefit to giving the water projects more flexibility in the November through January period so that exports can be restricted during the spring when large numbers juvenile chinook from all Central Valley races, including some of the spring-run chinook population, are most abundant and at great risk to loss in the Delta. Maintaining higher QWEST levels in the fall and winter months could also adversely affect upper Sacramento River temperature control operations if upstream reservoir releases are required to achieve the higher QWEST levels. In critically dry years, the Bureau of Reclamation intensively manages streamflows and reservoir storage levels to maintain suitable temperature conditions for salmon spawning and incubation and a conflict could arise.

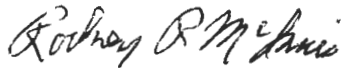
#### Research Needs

Protective measures for juvenile spring-run chinook salmon should be based on the best biological information concerning their use of the Delta, but the lack of information regarding their Delta residence time and smoltification period makes the development of an optimal protection plan difficult. Carefully designed fisheries investigations can provide information regarding overwintering areas, habitat needs, and the timing of smoltification for spring-run chinook salmon. These research efforts are crucial in order to make sound management decisions in the Delta.

On an interim basis, however, measures in place for winter-run chinook salmon from October through April should provide protection for the spring-run outmigration. If you have any questions regarding these comments please contact Mr. Jim Lecky at (310) 980-4015. You may also contact Mr. Chris Mobley or Mr. Gary Stern at (707) 578-7513. I look forward to continuing to

work with you to develop Bay-Delta water quality standards that will protect all chinook salmon populations and the ecosystem as a whole.

Sincerely,

  
for Hilda Diaz-Soltero  
Regional Director

cc: Cynthia Koehler, NHI  
Pat Brandes, FWS  
Deborah McKee, DFG

**VIA TELEFAX**

TO: Randy Lutter, OMB  
FROM: Tom Hagler, EPA-9  
RE: EPA Water Quality Criteria in California Bay/Delta  
DATE: December 9, 1994

This memorandum will summarize our call from this morning.

(1) Additional paragraph on the consensus process

The following paragraph will be added to page 21 (11/17 version) in the preamble, immediately before part B:

EPA is aware of efforts by urban and agricultural users, in cooperation with environmental groups, to identify alternative standards that may meet the requirements of the CWA. EPA encourages affected parties to continue to work with EPA and the State to develop proposals that meet the requirements of the CWA. EPA would welcome the adoption by the State of a revised plan based in whole or in part on such private proposals provided that it complies with the requirements of the CWA.

(2) Addition of a three-year moving average to Fish Migration criteria

Language will be added to both the rule and the preamble that measures compliance with the Fish Migration criteria by use of a three-year moving average.

[All page numbers refer to OMB submission version 11/17]

[Add to carryover paragraph of p. 169 in rule language and also to the end of the first full paragraph on p. 171]:

....These criteria will be considered attained when the sum of the differences between the measured experimental value and the stated criteria value (i.e., measured value minus stated value) for each experimental release conducted over a three year period (the current year and the previous two years)

shall be greater than or equal to zero.

[Add to carryover paragraph of p. 94 and again to end of second full paragraph on p. 105 in preamble text]:

....EPA recognizes that there may be substantial variation in fish migration criteria values resulting from these experimental releases. Accordingly, the final rule provides that attainment can be measured using a three-year moving average (the current year and two preceding years). Three year periods should provide time to complete sufficient releases to determine whether the implementation measures are, on average, attaining the stated criteria values.

(3) Elimination of surplus language in Fish Migration criteria

Paragraph (3)(B) ("Measuring San Joaquin Valley unimpaired runoff") on the last page of the rule will be revised as follows:

(a) The parenthetical in the first sentence of text shall be deleted, and

(b) The last two sentences shall be deleted.

(4) Sacramento Fish Migration: Measuring Temperature AT RELEASE

As I said on the phone, the 11/17 version corrects the "disconnect" you noted in the Sacramento Fish Migration. Namely, the final rule should compute the Sacramento Fish Migration values based on water temperature at release during the experiment. I'm including some pages from the 11/17 version that reflect this correction.

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high and very low temperatures, so the criteria must specify a ceiling on the index values at low temperatures and a floor for high temperatures. Incorporation of these conclusions and comments leads to Fish Migration criteria of at least the following:

At temperatures below 61°F:

SRFMC = 1.35

At temperatures between 61°F and 72°F:

SRFMC =  $6.96 - .092 * \text{Fahrenheit temperature}$

At temperatures above 72°F:

SRFMC = 0.34

In all cases, water temperature is measured as the temperature at release of tagged salmon smolts into the Sacramento River at Miller Park.

These final criteria are shown in Figure 5. Note that the "ceiling" and "floor" values in the final rule differ somewhat from those included in the documents made available in EPA's Notice of Availability (59 FR 44095). The changes were made to correct computational errors in evaluating the applicable "continuous function" values for the 61°F and 72°F ceiling and floor levels.

[INSERT FIGURE 5]

(IV) Implementation. On the Sacramento River, the criteria provide survival goals that vary based on the water temperature

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at the time of release of the tagged salmon smolts. EPA believes that the implementation plan developed by the State Board should provide for a sufficient number of fish releases each year to determine whether the criteria are being attained over a representative range of temperature conditions.

^ The State Board may consider using the USFWS Sacramento smolt survival model (that is, the model underlying the criteria index equations) to predict measures necessary to attain the criteria. There are a number of base conditions underlying both the tagged-fish release experiments and the USFWS models. For example, USFWS recommended a base Sacramento River flow to ensure that overall conditions do not deteriorate. The State should protect these base conditions as it develops an implementation plan.

Monitoring attainment of these criteria should focus on both within-year measures and across-year comparisons. During each year monitoring of salmon smolt survival should occur throughout the months of April, May and June with particular emphasis during times of temperature change or at times of change in water project operation. It is likely that this monitoring will reveal a large variability in survival at different times and under different conditions within each year. EPA anticipates that at the time of the next triennial review enough monitoring data over a range of temperatures will be available for a preliminary

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These criteria are displayed graphically in Figure 6.

(IV) Implementation of San Joaquin River Fish Migration Criteria.

The following discussion is intended to assist the State Board's consideration of the issues involved in implementing these or similar, equally protective, criteria.

The San Joaquin River Fish Migration criteria provide an annual survival goal that varies depending on the ~~60-20-20~~<sup>9</sup> San Joaquin ~~water year~~ index. EPA anticipates that the State Board implementation plan would provide for a sufficient number of tagged fish releases to verify that the applicable criterion is being met in each year.

Valley  
Index

As stated above, the USFWS model is the best available model of salmon smolt survival through the Delta, and EPA encourages the State Board to use the recently revised USFWS San Joaquin model as guidance for setting implementation measures. Nevertheless, it is important to recognize that there may be constraints on the model's use. Further monitoring and experimental releases under the chosen implementation regime are essential to verify and refine the model, and will ensure that the smolts are actually surviving at the expected level. In addition, it will be particularly important to protect the base conditions assumed in the model, such as flows during the time the barrier is not in

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(2) Fish Migration Criteria.

(1) General rule.

(a) Sacramento River. Measured Fish Migration criteria values for the Sacramento River shall be at least the following:

At temperatures less than below 61°F:  
SRFMC = 1.35

At temperatures between 61°F and 72°F:  
SRFMC = 6.96 - .092 \* Fahrenheit temperature

At temperatures greater than 72°F:  
SRFMC = 0.34

SRFMC is the Sacramento River Fish Migration criteria value.  
Temperature shall be the temperature at release of tagged salmon smolts into the Sacramento River at Miller Park.

(b) San Joaquin River. Measured Fish Migration criteria values on the San Joaquin River shall be at least the following:

For years in which the <sup>(SJVI)</sup>~~SJV~~Index is > 2.5:  
SJFMC = (-0.012) + 0.184\*SJVIndex

In other years: SJFMC = 0.205 + 0.0975\*SJVIndex

where SJFMC is the San Joaquin River Fish Migration criteria value, and SJVIndex is the San Joaquin Valley Index in million acre feet (MAF)

(ii) Computing fish migration criteria values for Sacramento River. In order to assess fish migration criteria values for the Sacramento River, tagged fall-run salmon smolts will be released into the Sacramento River at Miller Park and captured at Chipps Island, or alternatively released at Miller Park and Port Chicago and recovered from the ocean fishery, using the methodology described below. An alternative methodology for computing fish

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migration criteria values can be used so long as the revised methodology is calibrated with the methodology described below so as to maintain the validity of the relative index values. Sufficient releases shall be made each year to provide a statistically reliable verification of compliance with the criteria.

Fish for release are to be tagged at the hatchery with coded-wire tags, and fin clipped. Approximately 50,000 to 100,000 fish of smolt size (size greater than 75 mm) are released for each survival index estimate, depending on expected mortality. As a control for the ocean recovery survival index, one or two groups per season are released at Benecia or Pt. Chicago. From each upstream release of tagged fish, fish are to be caught over a period of one to two weeks at Chipps Island. Daylight sampling at Chipps Island with a 9.1 by 7.9 m, 3.2 mm cod end, midwater trawl is begun 2 to 3 days after release. When the first fish is caught, full-time trawling 7 days a week should begin. Each day's trawling consists of ten 20 minute tows generally made against the current, and distributed equally across the channel.

The Chipps Island smolt survival index is calculated as:

$$SSI = R + MT(.007692)$$

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maintains a port sampling program.

(iii) *Computing fish migration criteria values for San Joaquin River.* In order to assess annual fish migration criteria values for the San Joaquin River, tagged salmon smolts will be released into the San Joaquin River at Mossdale and captured at Chipps Island, or alternatively released at Mossdale and Port Chicago and recovered from the ocean fishery, using the methodology described below. An alternative methodology for computing fish migration criteria values can be used so long as the revised methodology is calibrated with the methodology described below so as to maintain the validity of the relative index values. Sufficient releases shall be made each year to provide a statistically reliable estimate of the SJFMC for the year.

Fish for release are to be tagged at the hatchery with coded-wire tags, and fin clipped. Approximately 50,000 to 100,000 fish of smolt size (size greater than 75 mm) are released for each survival index estimate, depending on expected mortality. As a control for the ocean recovery survival index, one or two groups per season are released at Benicia or Pt. Chicago. From each upstream release of tagged fish, fish are to be caught over a period of one to two weeks at Chipps Island. Daylight sampling

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Fran S. Hatfield  
~ 12/10/94

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Letter to P. Wright, EPA from E. Anton, SWRCB, Oct. 18, 1994  
RE: Narrative Standard for Protection of Tidal Marshes of Suisun Bay

Recommended revisions included the following:

- General language: "Water quality conditions sufficient to support...shall be maintained"; (certain conditions)..."shall not be permitted.
- "diversity" should be changed to "species composition"
- The standard should specify that it is meant to prevent permanent conversion to salt marsh. Natural variations occur in the tidal marshes as a result of radically varying hydrological cycles, and plant communities in particular can be expected to vary. The criterion should not be violated merely because a few salt marsh plants grow under changing conditions, where fresher water will be available during other time periods or water years. Likewise, the presence of animals that also inhabit salt marshes should not indicate a violation.
- The list of species should be deleted.

In addition the SWRCB was concerned that it would never be clear whether or not the criteria were being met, and that such narrative criteria could not be quantified objectively and would be difficult or impossible for the SWRCB to implement.

EPA's response to the SWRCB letter is as follows:

EPA agrees with points 1, 2 and 4 above, and the final narrative criteria are revised as suggested.

EPA does not agree with point 3. As an example, vegetation changes such as occurred in the recent drought caused loss and stunting of tules, and thus loss of habitat for Suisun song sparrow. Because precipitation is highly variable in the Bay/Delta watershed, one could argue that this habitat would be replaced at some future point in time, and therefore the change is not permanent. EPA does not agree that this is protective of the use. Past droughts (before water development) have undoubtedly caused reduced abundance in animal species as a result of degraded or lost habitat. However, springtime flows are now held back in reservoirs or diverted, and droughts have become more severe. For this reason, the extent of recent conversion of substantial stands of tules to salt marsh is unlikely to have happened historically. A "few salt marsh plants" growing under changing conditions would not

constitute a change from brackish to salt marsh.

The presence of animals that also inhabit salt marshes is characteristic of brackish marshes. One of the unique aspects of the Suisun Bay brackish marshes is that they support salt marsh vegetation and associated animal species at higher elevations and fresher water vegetation at lower elevations. This is why it is important to protect a natural gradient in species composition and wildlife habitat.

EPA also does not agree with the statement made by the commenter that such narrative criteria could not be quantified objectively and would be difficult or impossible for the SWRCB to implement. Such measures of ecosystem health as diversity, population abundance, and plant stature or percent cover can be quantified. Because this information would be difficult to obtain for a large number of species or biological communities, it will be important to identify the species and communities most vulnerable to changes in water and soil salinity, or other water quality parameters. The list of species in the preamble to the final rule (and originally included in the proposed criteria) provides this direction. However, as suggested by the commenter, this list has not been included in the final criteria because other vulnerable species may be identified in the future, and this should not require re-proposal.

**MEMORANDUM**

**Date:** December 14, 1994  
**From:** Susan Hatfield  
**To:** Tom Hagler  
**Subject:** CVPIA Doubling Information for Final Rule  
Administrative Record

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Attached are draft tables developed for the CVPIA doubling plan, and provided EPA by USFWS. They compare EPA criteria (assuming the implementation measures listed) with a doubling goal of doubling survival in the Delta.

Table 8. SACRAMENTO FALL-RUN (APRIL-JUNE)

	DAYFLO W	OP STUDY	EPA*	A	B	B1	C	D	E	Doubling Goal
W	.45	.42	.50	.51	.52	.52	.54	.57	.45	.90
AN	.33	.29	.38	.39	.39	.40	.41	.44	.37	.66
BN	.25	.23	.36	.36	.37	.37	.38	.41	.32	.50
D	.19	.17	.29	.29	.29	.29	.31	.32	.27	.38
C	.24	.22	.34	.34	.34	.34	.36	.38	.30	.48
X	.34	.31	.41	.42	.42	.43	.44	.47	.37	.68

\*EPA: Cross channel closed (A-J), 1500 exports (4/15-5/15), 2000, 3000, 4000, 5000, 6000 cfs exports critical, dry, below normal, above normal, wet water year types respectively (4/1-4/14, 5/16-6/30).

Option A: Cross channel closed (A-J), 1500 exports (4/15-5/31) 2000, 3000, 4000, 5000, 6000 critical, dry, below normal, above normal, wet water year types respectively (4/1-4/14, 6/1-6/30).

Option B: Cross channel closed (A-J) 1500 exports (4/1-5/31) 2000, 3000, 4000, 5000, 6000 critical, dry, below normal, above normal, wet water year types respectively (6/1-6/30).

Option B1: Cross channel closed (A-J), 1500 exports (4/1-6/30).

Option C: Cross channel closed (A-J), 0 exports (A-J).

Option D: Cross channel closed (A-J) Georgiana Slough closed (A-J).

Option E: Peripheral Canal with 15% loss at screens.

X = Average for all years between 1965-1989.

#### Model Assumptions:

1. Migrational distribution = 17% April, 65% May, 18% June.
2. Temperatures based on mean monthly temperatures at Freeport from USGS.
3. Sacramento fall run smolt model used to estimate survival.

TABLE 11

## SAN JOAQUIN FALL RUN

	DAYFLO W	OP STUDY	EPA	A	B	B4 (A,B or C)	C1	C	D	Doublin g Goal
W	.34	.22	.38	.38	.68	.50	.27	.57	.80	.68
A N	.08	.06	.20	.20	.16	.30	.22	.46	.65	.16
B N	.04	.05	.15	.16	.08	.20	.17	.35	.50	.08
D	.04	.04	.13	.13	.08	.16	.12	.24	.36	.08
C	.04	.03	.13	.14	.08	.14	.09	.15	.24	.08
X	.16	.12	.24	.25	.33	.32	.19	.40	.57	.32

EPA: UOR barrier (4/15-5/15), 1500 exports (4/15-5/15), 2000, 3000, 4000, 5000, 6000 exports (4/1-4/14, 5/16-5/31), critical, dry, below normal, above normal, and wet years respectively, 4000, 4000, 6000, 8000, 10,000, flows in cfs, (4/15-5/15) at Vernalis.

Option A: No UOR barrier, 1500 exports (4/15-5/15), 2000, 3000, 4000, 5000, 6000 exports (4/1-4/14, 5/16-5/31), critical, dry, below normal, above normal and wet years respectively; increase flows (4/1-5/31), to 16000 (W), 7500 (AN), 6000 (BN), 5000 (D), 4500 (C).

Option B: No UOR barrier, 1500 exports (April-May), increased flows (4/1-5/31) to : (W) 29000, (AN) 5500, (BN) 2000, (D) 2000, (C) 2000.

Option B4 A: No UOR barrier, 1500 exports (April-May), (4/1-5/31) flows increased to (W) 21000, (AN) 12000, (BN) 8000, (D) 6000, (C) 4500.

B: UOR barrier (4/15-5/15), 1500 exports (4/15-5/15), increase flows (4/15-5/15) to 24500 (W), 18000 (AN), 12000 (BN), 8000 (D), 6000 (C).

C: UOR barrier (4/1-5/31), 1500 exports (4/1-5/31), increase flows (4/1-5/31) to 13700 (W), 7000 (AN), 3700 (BN), 2500 (D), 1500 (C).

Option C1: No UOR barrier (April-May), 0 exports (April-May), 2000, 4000, 6000, 8000 and 10,000 cfs at Vernalis in critical, dry, below normal, above normal and wet years respectively

Option C: No UOR barrier, 0 exports (April-May), 2000-10,000 cfs at Stockton (April-May).

Option D: UOR barrier (April-May), 0 exports (April-May) 2000-10,000 cfs at Stockton (April-May).

X = Average for all years between 1965-1989.

## Model Assumptions:

1. Migrational Distribution 45% April, 55% May.
2. Temperature at Jersey point estimated from Neomysis studies.
3. San Joaquin smolt model used to estimate survival.

MEMORANDUM

**Date:** December 14, 1994  
**From:** Susan Hatfield  
**To:** Tom Hagler  
**Subject:** San Joaquin Protective Measures Recommended by  
Various Plans

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The attached Table summarizes Delta protective measures for salmon from various plans. The CVPIA information is not up to date.

Recommended Delta Protective Measures for Salmon

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	1994 Delta smelt Biological opinion	Long-term Biological Opinion for Winter-run Chinook	SJRWMP Action Plan for San Joaquin Fall-run Chinook Salmon Populations	CDFO Central Valley Salmon and Steelhead Restoration and Enhancement Plan	DFG Plan for Restoring Central Valley Streams (above Delta)
SACRAMENTO RIVER: Cross Channel Gate; Georgiana Slough Closure		Cross Channel gates closed from Feb. 1 through April 30		Closing or screening Delta Cross Channel; screening Georgiana Slough	
SACRAMENTO RIVER: flow	Net delta outflow of 6800 and 12000 cfs for specified number of days.	Minimum flow of 3,250 cfs from Keswick Dam from Oct. 1 through March 31		Maintain minimum flows at Rio Vista	Sacramento R. flow (in cfs) at Shasta storage of: $\leq 2.8$ MAF Oct 1-Apr 30 3500 May 1-Sept 30 4000 $\geq 2.8$ MAF All year 4500
SAN JOAQUIN RIVER: Upper Old River Barrier			Evaluate & install barrier April 1 - May 31. Install in fall to alleviate D.O. and temperature problems for adult upstream migrants	Modification at head of Old River so that not more than 20% of flow enters Old River April 1 to June 15; also in fall to maintain D.O above 5 ppm.	
SAN JOAQUIN RIVER: flow	If Delta smelt present Jan - March; avg flows of 5200, 3600, 3200, 2600, & 2400 cfs in W, AN, BN, D & C for 30 days in period from April 1 - May 15. Otherwise minimum avg of 2000, 2000, 1500, 1200 & 800 cfs as part of outflow requirements for specified number of days.		Augment April and May flow at Vernalis and into the South Delta; "controlled freshet" recommendations to the SWRCB "could be beneficial." Fall attraction flows for adult upstream migrants.	Minimum flow at Mossdale; pulse flow in late April and/or early May.	Establish interim minimum outflow objectives at Vernalis of 10000, 8000, 6000, 4000, & 2000 in W, AN, BN, D, & C years, respectively for April 15 through May 15. Establish interim objectives to protect upstream migration.
BOTH RIVERS: temperature				Decrease water temperatures.	Establish temperature objectives at Vernalis fall and spring.
BOTH RIVERS: Export constraints	Variable, based on incidental take limits	Variable, based on incidental take limits	Link exports with Vernalis flows. "controlled freshets," improved screening, and Old River barrier to provide positive San Joaquin R. flow	Curtail exports at peak migration periods; restrict total exports to less than San Joaquin River flow.	
SAN JOAQUIN RIVER: QWEST		No reverse flows from Feb. 1 through April 30. > - 2000 cfs from Nov. 1 through Jan. 31. 14-day running averages, 7-day running average must be within 1000 cfs of target, if below it.	Provide positive San Joaquin R. flow through the San Joaquin Delta in April and May.		
Other			Fish protective devices on diversions; alternative water supplies for riparian diversions April - May	New pump intake facility with screen and downstream bypass flow; screen agricultural diversions	

# Recommended Delta Protective Measures for Salmon

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	EPA Salmon Criteria	USFWS, NMFS, DFG D-1630 Recommendations to SWRCB	SWRCB D-1630	CVPIA Doubling Plan (possible actions for salmon passage through Delta)	800,000 af CVP yield dedication for 1994 (a critically dry year)
<b>SACRAMENTO RIVER: Cross Channel Gate; Georgiana Slough Closure</b>	Closure of gates from April 1 to June 30, or other method of lowering proportion of juvenile migrants entering central Delta.	Closure of Cross Channel Gates April 1 to June 30; closure of Georgiana Slough April 15 to June 15.	Operated between Feb. 1 and June 30 when 'significant numbers present' based on real-time monitoring.	Close Cross Channel gates at critical periods; divert fish through Sutter and Steamboat Sloughs, build a behavioral barrier; screen head of Cross Channel; build diversion to Mokelumne River, close Cross Channel and Georgiana Slough.	
<b>SACRAMENTO RIVER: flow</b>	no flows required for salmon; implementation measures based on assumption that May through June flows and associated temperatures will not change substantially from recent levels.	Minimum flow at Rio Vista of 4000 cfs from April 1 to June 30.	Pulse flow of $\geq 18,000$ cfs for 14 consecutive days during hatchery release of smolts.	To reduce straying, migration delay and susceptibility to entrainment: increase flows, pulse flows at critical periods, isolated Delta facility properly sized.	Upstream release from Keswick and Folsom, respectively, of 4,500 & 1500 cfs in Oct.; $\geq 4000$ & 1750 cfs Nov. through Feb.; and $\geq 4000$ & 1500 in March for spawning and rearing of salmon & steelhead; in Feb & March for Delta smelt.
<b>SAN JOAQUIN RIVER: Upper Old River Barrier</b>	Required from April 15 to May 15	Required from April 1 to May 31.	Not required.	Full rock barrier in spring, partial rock barrier in fall.	
<b>SAN JOAQUIN RIVER: flow</b>	average flows $\geq 10,000$ , 8,000, 6,000, 4,000, 4,000 cfs in W*, AN, BN, D, C yrs respectively for 30 consecutive days during spring (April-May). Translated into continuous function.	$\geq 10000$ , 8000, 6000, 4000, 2000 cfs in W, AN, BN, D, & C yrs respectively from April 15 to May 15.	$\geq 10000$ , 8000, 6000, 4000, 2000 cfs in W, AN, BN, D, C yrs respectively for 21 consecutive days during spring (April-May). Pulse flow of $\geq 2000$ cfs for 14 consecutive days in the fall.	increase flow at Vernalis; pulse flows at critical periods.	Release to Stanislaus River approx. 68,000 af from April 15 to May 15 to provide at least 1500 cfs flow for salmon and steelhead outmigrants, as well as Delta smelt & striped bass eggs & larvae.
<b>BOTH RIVERS: temperature</b>					
<b>BOTH RIVERS: Export constraints</b>	1500 cfs for 30 days during San Joaquin pulse flow; $\leq 6000$ , 5,000, 4000, 3,000, 2,000 cfs W*, AN, BN, D, C yrs respectively April through June for rest of period	6000, 5000, 4000, 3000, 2000 cfs in W, AN, BN, D & C respectively for April 15 to May 15.	1500 cfs for 21 days during San Joaquin pulse flow; $\leq 4000$ cfs April through June in C & D yrs; $\leq 6000$ cfs BN, AN, W yrs for rest of period; constraints relaxed when Delta outflow > 50,000 cfs.	Reduce exports.	Curtail pumping by 200,000 af for 30 days to coincide with San Joaquin pulse flow, so that the combined (CVP, SWP & CCC) export rate will be $\leq 1500$ cfs during this time.
<b>SAN JOAQUIN RIVER: QWEST</b>		Flow at Jersey Point 3000, 2500, 2000, 1500, 1000 cfs for W, AN, BN, D & C respectively April 15 to May 15; 1000 cfs remaining time in April and May.	>0 cfs Feb 1 - June 30; constraints relaxed when exports < 2000 cfs.	Eliminate reverse flows.	

\*Water year types are: W = wet; AN = above normal; BN = below normal; D = dry; C = critically dry

MEMORANDUM

**Date:** December 14, 1994  
**From:** Susan Hatfield  
**To:** Tom Hagler  
**Subject:** Comparison between San Joaquin fish migration  
criteria and historical survival indices, using  
revised San Joaquin model

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Attached are spreadsheets with historical 1956-1970 estimates of survival, using revised San Joaquin model (Brandes, 1994), and average criteria for these two years using the continuous line criteria and also modelling the average implementation measures.

10/24/94 Corrected

Historical estimates of survival using USFWS  
San Joaquin model

YEAR	WYR INDEX	SURVIVAL INDEX	AVERAGES	
1958	W	0.54		
1969	W	0.52		
1967	W	0.42		
1956	W	0.29		
1965	W	0.20	0.39	
1963	AN	0.23		
1970	AN	0.06	0.14	0.32 average w. an
1957	BN	0.06		
1962	BN	0.06		
1966	BN	0.02	0.05	0.24 average w, an, bn
1968	D	0.03		
1959	D	0.02		
1964	D	0.01	0.02	
1960	C	0.01		
1961	C	0.00	0.00	0.01 average d, c
		0.16		

criteria	crit/1.8	wyind	Class	Year
1.11	0.62	6.095	W	1969
0.87	0.48	4.773	W	1958
0.95	0.53	5.252	W	1967
0.69	0.38	3.812	W	1965
0.81	0.45	4.463	W	1956
0.65	0.36	3.573	AN	1963
0.57	0.32	3.183	AN	1970
0.55	0.31	3.073	BN	1962
0.54	0.30	3.008	BN	1957
0.45	0.25	2.514	BN	1966
0.42	0.23	2.187	D	1964
0.42	0.23	2.215	D	1968
0.42	0.23	2.209	D	1959
0.39	0.21	1.854	C	1960
0.34	0.19	1.375	C	1961

avg      0.611844   0.339913

## W/barrier

			Vernal F	CD	exp	exp/v-cd
1963	AN	4	1395	8000	-2218	1500 0.185953
1970	AN	4	2320	8000	1392	1500 0.188484
1962	BN	4	1698	6000	1611	1500 0.25203
1957	BN	4	1967	6000	-380	1500 0.249526
1966	BN	4	2051	6000	1508	1500 0.251899
1960	C	4	1530	4000	948	1500 0.377685
1961	C	4	1664	4000	1105	1500 0.378134
1964	D	4	1580	4000	1560	1500 0.379439
1968	D	4	2000	4000	1467	1500 0.379172
1959	D	4	1597	4000	799	1500 0.377261
1969	W	4	9699	10000	960	1500 0.150433
1958	W	4	14036	14036	-3301	1500 0.106117
1967	W	4	6858	10000	-2135	1500 0.149045
1965	W	4	2051	10000	168	1500 0.150076
1956	W	4	2891	10000	110	1500 0.15005

## without barrier

			Vernal F	CD	exp	exp/v-cd
1963	AN	4	1395	1395	-2218	5000 3.420511
1970	AN	4	2320	2320	1392	5000 2.194889
1962	BN	4	1698	1698	1611	4000 2.425007
1957	BN	4	1967	1967	-380	4000 2.022071
1966	BN	4	2051	2051	1508	4000 1.994436
1960	C	4	1530	1530	948	2000 1.332205
1961	C	4	1664	1664	1105	2000 1.226211
1964	D	4	1580	1580	1560	3000 1.956513
1968	D	4	2000	2000	1467	3000 1.533444
1959	D	4	1597	1597	799	3000 1.907208
1969	W	4	9699	9699	960	6000 0.620439
1958	W	4	14036	14036	-3301	6000 0.424467
1967	W	4	6858	6858	-2135	6000 0.866735
1965	W	4	2051	2051	168	6000 2.932867
1956	W	4	2891	2891	110	6000 2.077548

Stktn F	UOldR F	p2 Stkn	p3 UOldR	TempJPt	m2	m34	m3
3243	0	1.00	0.00	60	1.01	0.26	0.65
3176	0	1.00	0.00	58	1.01	0.18	0.65
2335	0	1.00	0.00	66	1.01	0.60	0.71
2372	0	1.00	0.00	60	1.01	0.41	0.71
1765	0	1.00	0.00	60	1.01	0.41	0.75
1146	0	1.00	0.00	63	1.01	0.63	0.79
370	0	1.00	0.00	58	1.01	0.52	0.85
1137	0	1.00	0.00	58	1.01	0.52	0.80
1138	0	1.00	0.00	60	1.01	0.56	0.80
1149	0	1.00	0.00	60	1.01	0.56	0.79
4020	0	1.00	0.00	59	1.01	0.06	0.59
5789	0	1.00	0.00	59	1.01	0.00	0.47
4078	0	1.00	0.00	59	1.01	0.06	0.59
4035	0	1.00	0.00	58	1.01	0.01	0.59
4036	0	1.00	0.00	58	1.01	0.01	0.59

Stktn F	UOldR F	p2 Stkn	p3 UOldR	TempJPt	m2	m34	m3
140	1256	0.10	0.90	60	0.97	0.88	0.87
459	1861	0.20	0.80	58	0.95	0.84	0.84
292	1406	0.17	0.83	66	0.97	0.91	0.86
442	1525	0.22	0.78	60	0.96	0.85	0.84
370	1681	0.18	0.82	60	0.96	0.86	0.85
340	1190	0.00	1.00	63	0.97	0.87	0.85
88	1576	0.00	1.00	58	0.96	0.85	0.87
284	1296	0.18	0.82	58	0.97	0.84	0.86
417	1583	0.21	0.79	60	0.96	0.85	0.85
301	1296	0.19	0.81	60	0.97	0.86	0.85
3458	6242	0.36	0.64	59	0.82	0.67	0.63
5352	8685	0.38	0.62	59	0.75	0.00	0.50
2327	4532	0.34	0.66	59	0.87	0.74	0.71
272	1778	0.13	0.87	58	0.96	0.86	0.86
625	2266	0.22	0.78	58	0.94	0.84	0.83

m4	m234	s234	month	Vernal F	CD	exp	exp/v-cd	
	0.00	0.26	0.74	5	8000	1496	1500	0.188558
	0.00	0.18	0.82	5	8000	2406	1500	0.189207
	0.28	0.60	0.40	5	6000	2074	1500	0.25262
	0.00	0.41	0.59	5	6000	943	1500	0.251184
	-0.07	0.41	0.59	5	6000	2134	1500	0.252696
	0.10	0.63	0.37	5	4000	1978	1500	0.380647
	0.00	0.52	0.00	5	4000	2254	1500	0.381448
	0.00	0.52	0.48	5	4000	2104	1500	0.381012
	-0.07	0.56	0.44	5	4000	2294	1500	0.381565
	0.00	0.56	0.44	5	4000	2434	1500	0.381973
	0.00	0.06	0.94	5	10000	2374	1500	0.151076
	0.00	0.00	1.00	5	14036	1694	1500	0.107254
	0.00	0.06	0.94	5	10000	2298	1500	0.151041
	0.00	0.01	0.99	5	10000	2394	1500	0.151085
	0.00	0.01	0.99	5	10000	1416	1500	0.15064

m4	m234	s234	month	Vernal F	CD	exp	exp/v-cd	
	0.00	0.96	0.04	5	1398	1496	5000	3.694181
	0.00	0.93	0.07	5	2472	2406	5000	2.083906
	0.41	0.96	0.04	5	1724	2074	4000	2.407695
	0.00	0.94	0.06	5	1837	943	4000	2.211056
	0.05	0.94	0.06	5	1919	2134	4000	2.15673
	0.13	0.97	0.03	5	1480	1978	2000	1.408133
	0.00	0.96	0.00	5	1350	2254	2000	1.560111
	0.00	0.95	0.05	5	1252	2104	3000	2.523341
	0.00	0.94	0.06	5	1642	2294	3000	1.90665
	0.00	0.95	0.05	5	1317	2434	3000	2.411498
	0.00	0.77	0.23	5	24797	2374	6000	0.242667
	0.00	0.46	0.54	5	3984	1694	6000	1.5256
	0.00	0.83	0.17	5	8650	2298	6000	0.699188
	0.00	0.94	0.06	5	3772	2394	6000	1.621403
	0.00	0.92	0.08	5	4472	1416	6000	1.354701

Stktn F	UOldR F	p2 Stkn	p3 UOldR	TempJPt	m2	m34	m3
3174	4826	1.00	0.00	64	0.87	0.71	0.65
3157	4843	1.00	0.00	63	0.87	0.69	0.65
2326	3674	1.00	0.00	68	0.90	0.83	0.71
2347	3653	1.00	0.00	65	0.90	0.77	0.71
1755	4245	1.00	0.00	65	0.88	0.81	0.75
1130	2870	1.00	0.00	62	0.92	0.81	0.80
1126	2874	1.00	0.00	64	0.92	0.83	0.80
1128	2872	1.00	0.00	61	0.92	0.79	0.80
1125	2875	1.00	0.00	65	0.92	0.84	0.80
1123	2877	1.00	0.00	69	0.92	0.89	0.80
3994	6006	1.00	0.00	65	0.83	0.68	0.59
5696	8341	1.00	0.00	69	0.76	0.71	0.47
3996	6004	1.00	0.00	65	0.83	0.68	0.59
3994	6006	1.00	0.00	64	0.83	0.66	0.59
4012	5988	1.00	0.00	63	0.83	0.63	0.59

Stktn F	UOldR F	p2 Stkn	p3 UOldR	TempJPt	m2	m34	m3
72	1327	0.05	0.95	64	0.97	0.91	0.87
504	1968	0.20	0.80	63	0.95	0.89	0.84
294	1429	0.17	0.83	68	0.97	0.93	0.86
363	1475	0.20	0.80	65	0.97	0.90	0.85
319	1600	0.17	0.83	65	0.96	0.90	0.85
308	1171	0.00	1.00	62	0.98	0.86	0.85
263	1086	0.00	1.00	64	0.98	0.88	0.86
172	1080	0.00	1.00	61	0.98	0.87	0.86
292	1350	0.00	1.00	65	0.97	0.90	0.86
188	1129	0.14	0.86	69	0.98	0.94	0.86
9748	15048	0.39	0.61	65	0.56	0.55	0.18
1053	2931	0.26	0.74	69	0.92	0.94	0.80
2994	5656	0.35	0.65	65	0.84	0.81	0.66
951	2821	0.25	0.75	64	0.93	0.88	0.81
1262	3210	0.28	0.72	63	0.91	0.86	0.79

m4	m234	s234	total s					
0.16	0.71	0.29	0.49	0.29				
0.10	0.69	0.31	0.54	0.31	0.52	0.30	0.05	
0.40	0.83	0.17	0.27	0.17				
0.22	0.77	0.23	0.59	0.23				
0.22	0.81	0.19	0.59	0.19	0.48	0.20	0.05	
0.04	0.81	0.19	0.37	0.19				
0.16	0.83	0.17	0.00	0.17	0.18	0.18	0.01	
-0.01	0.79	0.21	0.48	0.21				
0.22	0.84	0.16	0.44	0.16				
0.45	0.89	0.11	0.44	0.11	0.45	0.16	0.05	
0.22	0.68	0.32	0.94	0.32				
0.45	0.71	0.29	1.00	0.29				
0.22	0.68	0.32	0.94	0.32				
0.16	0.66	0.34	0.99	0.34				
0.10	0.63	0.37	0.99	0.37	0.97	0.33	0.22	

m4	m234	s234	total s					
0.34	0.97	0.03	0.04	0.03				
0.28	0.94	0.06	0.07	0.06	0.05	0.05		
0.52	0.96	0.04	0.04	0.04				
0.35	0.95	0.05	0.06	0.05				
0.35	0.95	0.05	0.06	0.05	0.05	0.04		
0.07	0.98	0.02	0.03	0.02				
0.19	0.98	0.02	0.00	0.02	0.01	0.02		
0.06	0.98	0.02	0.05	0.02				
0.30	0.97	0.03	0.06	0.03				
0.53	0.97	0.03	0.05	0.03	0.05	0.03		
0.45	0.56	0.44	0.23	0.44				
0.68	0.93	0.07	0.54	0.07				
0.45	0.83	0.17	0.17	0.17				
0.39	0.92	0.08	0.06	0.08				
0.33	0.90	0.10	0.08	0.10	0.22	0.17		

0.05      0.21      0.42

0.04      0.18      0.54

0.02      0.09      0.18

0.03      0.16      0.48

0.17      0.40      2.00

3.62837  
0.241891